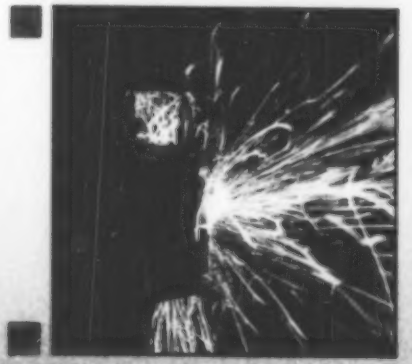
quality management



how and why

Québec

quality management

how and why

Gouvernement du Québec
Ministère de l'Industrie
et du Commerce

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WHY IS QUALITY MANAGEMENT NECESSARY?

A Montréal company producing electrical appliances is forced to buy parts from Japan because local suppliers cannot deliver parts of acceptable quality. On the other hand, a small Québec-based company specializing in plastic products has implemented a quality management system, and is winning large contracts with major customers.

North American society has, over the years, become used to affluence, with a flourishing economy and tolerant consumers. However, the oil crisis and subsequent economic recessions have driven up both interest rates and inflation, while unemployment has set new records. Buyers, consumers, people in industry and trade have become more demanding; these days, they are looking for products that are reliable and durable. In other words, they want *quality products*. The task facing industry is not an easy one. The industrialized countries of the Far East, especially Japan, are experiencing tremendous economic expansion and their quality products have invaded our markets, our factories, our offices and our homes. To meet the challenge, we must act quickly. But how?...

Every manager knows that to meet objectives and remain competitive, the company must provide its customers with a quality product, in sufficient numbers, on time and at the lowest possible price. It has been observed, however, that managers tend to concentrate on quantity, deadline, and cost reduction requirements, while relegating quality to a lesser priority.

What are the reasons for this?

Generally, the company takes the purchasers' priorities into account. For a long time, purchasers had focused mainly on obtaining the required quantity at a reasonable price, as soon as possible. Today, however, purchasers are placing more and more emphasis on quality.

Consequently, managers must adjust to purchasers' new priorities.

Figure 1. Quality and three constraints: quantity, deadline and cost.

WHAT IS THE COST OF QUALITY?

Quality does not cost anything. If each person does what he or she has to do right the first time, no additional expenditure is needed to meet quality objectives. What is costly are *un-quality* and *excess quality*. *Un-quality* can result from faulty design, deficient raw material or poor workmanship, and is the cause of rework and rejects. Un-quality necessitates high inventory levels to make up for rejects, complaints and even legal action. It may cost a firm a contract, a customer or even a market. Excess quality can also be costly, by unduly increasing costs and, by the same token, reducing profits.

Un-quality can cost an industrial firm more than 20 % of its annual sales, so that a firm with a profit-sales ratio of 15 % could more than double its profits by eliminating un-quality.

Improving quality helps to cut costs and thus raise profits. It also makes the firm more competitive by inspiring greater confidence in its products. As a result, the firm increases its sales and its market share and thus guarantees its survival and growth.

Note that un-quality and excess quality are not restricted to the manufacturing stage: they are problems that affect every phase from design to after-sale service.

WHO IS RESPONSIBLE FOR QUALITY WITHIN THE FIRM?

The quality of every firm's product is the responsibility of the entire workforce: from the designers to the inspectors, including the administrators, operators and sales force. It is therefore essential to coordinate the activities of all these people to eliminate, or at least reduce, the chances of insufficient or excessive quality.

Quality management, then, seems important but, first...

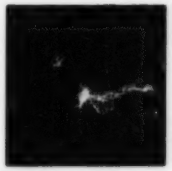
WHAT IS QUALITY?

The question: "In your opinion, what is quality?" produces different replies, depending on who is answering!

In Marketing, it is what makes a product ***marketable****. In Production, it is the* ***conformance*** *of a product to a design, a specification, a standard, and for Purchasing, it is frequently a* ***minimum performance level*** *to be met. Finance tends to view it as a product that is* ***profitable****, while some operators gauge quality in terms of* ***lack of reaction*** *from the foreman! For the user, it is the product's capacity to* ***satisfy a need****.*

From this, we can conclude that the notion of quality depends on who is defining it. However, since a firm's profits depend on customer satisfaction, any activity related to quality must have the customer's satisfaction as its final objective.

HOW IS THE QUALITY OF A PRODUCT MEASURED?



Let us begin by defining the characteristics a product must have if it is to satisfy the user's needs. To define them, the purpose to which the product will be put has to be determined (cutting, carrying, welding, amusing, heating, cooling, etc.). This is called *suitability for intended use*.

The next criterion to be assessed is the product's desirable useful life, or its *durability*.

Some customers demand to know, or themselves specify, the probability that a product can be used without breaking down during a specific period of time. This is called *reliability*.

It is sometimes useful to know, for a large number of products, whether they can maintain their level of quality throughout their useful life, with limited upkeep and minimum repairs. This is called *maintainability*.

Other characteristics may also be required of a product, such as the level of toxicity, flexibility, stability, habitability, interchangeability.

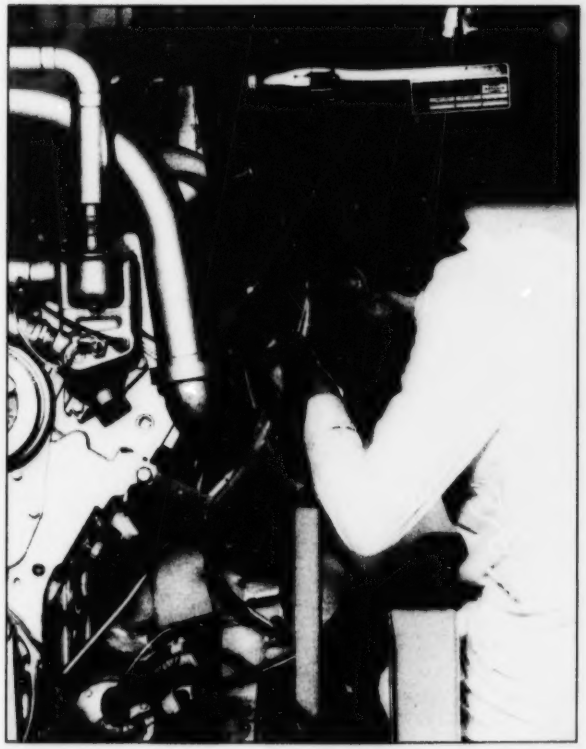


Figure 2. The finished product: satisfying a need.

WHERE DOES QUALITY START AND WHERE DOES IT END?

The quality cycle

Once the user's need is known — or the characteristics of the product likely to satisfy this need — specifications must be established for the materials required to produce it, and for the processes which will be used to transform these materials into finished products. The preparation stage is next: preparing manpower and equipment, purchasing the raw materials, parts or components needed. These are processed into finished goods, which are then transported, stored, installed, used, repaired if need be and finally disposed of at the end of their useful life. Ideally, the product will have satisfied the user's need. If it fails to do so, or if there is a change in the user's need, the process starts over.

WHAT IS QUALITY MANAGEMENT?

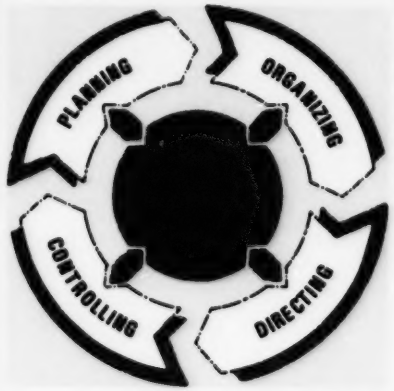


Figure 3. The management process.

The first thing to be said is that the goal of management in general is to optimize the utilization of available resources to achieve an objective. The management process consists of the following five activities:

- ***Planning**: determining the objectives to achieve and the means to employ;*
- ***Organizing**: establishing operating methods to achieve objectives efficiently (structures, systems, procedures);*
- ***Directing**: guiding personnel towards the achievement of objectives (motivation, leadership, management style);*
- ***Controlling**: measuring results and comparing them with objectives so as to detect differences to be corrected;*
- ***Assuring**: checking to see if planning, organizing, directing and controlling activities are sufficient for the attainment of objectives.*

"*Quality Management*" consists in applying this process to quality. The coordinated management of all activities for achieving quality in every phase of the quality cycle is called "*Total Quality Control*" or TQC. In TQC, all the firm's operations play a part in the various activities of the quality management process. The notions of "quality management," "quality control" and "quality assurance" should not be confused.

What methods are used to achieve quality?

These methods are commonly known as "the seven Ms":

- *Trained, informed, and motivated* ***manpower.***
- ***Machines,*** *which include production, measurement and storage equipment and must be suitable and well maintained.*
- ***Materials,*** *parts and subassemblies, which are used in making the product and which must conform to the required quality level.*
- *A favourable* ***milieu*** *for achieving quality: this includes the outside environment or relations with customers, suppliers, etc., and the internal environment, management and all the firm's operations.*
- *Sufficient* ***money*** *to adequately perform all the activities necessary for achieving quality.*
- *Work* ***methods*** *that are well designed and carefully applied.*
- *Effective* ***management*** *that includes planning, organizing, directing, controlling and assuring activities.*

Once the system is operating, failure to achieve the quality objective is considered a problem, of which "the seven Ms" are possible causes. Which of them are the most likely causes can be determined through analysis, and corrective action can then be undertaken. The consequences of a quality problem may be:

- a drop in output;
- failure to meet deadlines;
- increased costs.

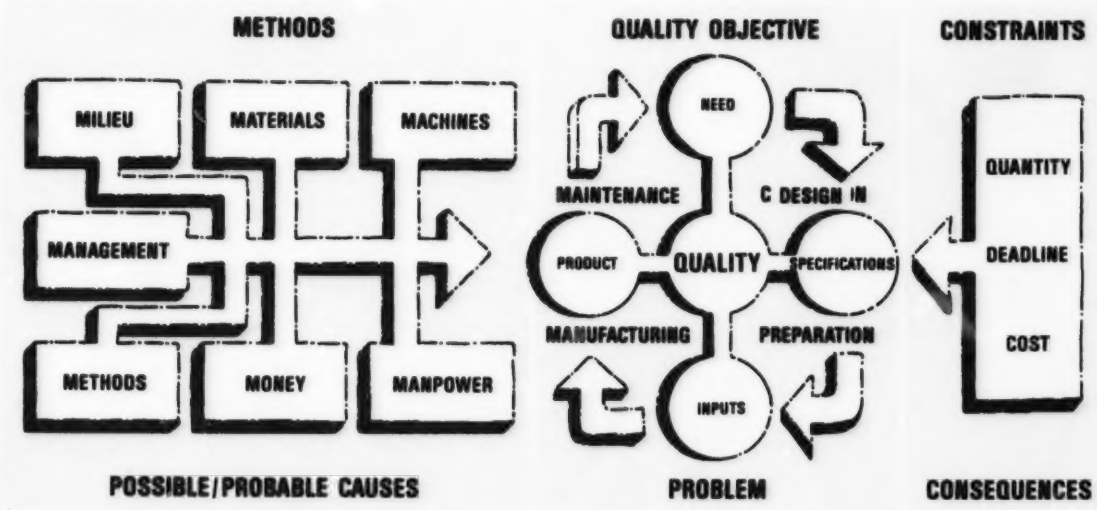


Figure 4. Total quality management.

HOW CAN THE COSTS OF UN-QUALITY AND OF EXCESS QUALITY BE REDUCED?

How can you determine what proportion of your firm's profits is lost because the quality of its goods is either too high or too low? By measuring the cost of un-quality and the cost of excess quality.

The cost of un-quality is the total of the following costs:

1. Cost of failures	**internal**: repairs, rework, rejects,... **External**: processing customers complaints, service performed under warranty...
2. Cost of control	Payroll of staff assigned to inspection and testing, and cost of materials and parts used in testing...
3. Cost of prevention	Payroll of staff assigned to the firm's quality system, to evaluating suppliers, to quality awareness sessions,...

As we mentioned earlier, un-quality may cost a firm more than 20 % of its sales and several times its profits. Reducing these costs is therefore an excellent way to increase the firm's profitability.

A precise measurement of these costs is not absolutely necessary to convince you of the need to begin a quality initiative. However, if you intend to monitor the progress of your firm's quality performance, greater precision will be needed and it may be useful to incorporate certain changes in your accounting system in order to record and code the items making up the costs of un-quality.

What is the best strategy for reducing these costs to a minimum?

A designer's calculation error will have little cost impact if he notices it immediately and corrects it. However, if the error is only detected and corrected later, its effect will be much greater. Costs accelerate in proportion to the time elapsed since the error was made. That is why self-checking is so important. Each operator is responsible for correcting his own errors, and has the opportunity to do so before they are passed on to others.

Detecting errors and correcting them at an early stage is good, but preventing them is even better, because this contributes to reducing production costs. Firms which spend more on prevention succeed in appreciably reducing their relative costs of un-quality.

What are your relative costs of un-quality, and what proportion of these costs go to prevention, i.e. to training your staff, to qualifying your procedures, to determining and eliminating causes of problems, etc.?

If you do not know, you should find out.

UNDER WHAT CONDITIONS CAN THE WORKFORCE PRODUCE QUALITY?

Every member of the workforce involved in the design, development, preparation, manufacture and quality maintenance of a product must be made aware of the importance of doing what he or she has to do well, the first time.

The worker must:

- **Know** what to do: have all the information required to do his or her work (objectives, procedures, results obtained);
- **Be able** to do it: have the training, skill and experience needed for the type of job he or she has been assigned;
- **Want** to do it well the first time: be motivated.

How can management motivate the workforce?

The first thing to be said is that it is important that management be motivated to achieve quality. It is impossible to convince somebody of something you do not believe in yourself!

Management can motivate employees in every department by directly relating the quality of what is produced to the satisfaction of their personal needs.

What are these needs?

First come the *physiological* needs (hunger, thirst, housing, clothing...), which are generally satisfied through the money earned from the job. But jobs depend on sales, and without quality, sales disappear. So, the importance of quality is apparent. The workforce must realize that without quality, sales and jobs will disappear.

Security, the second type of need, is related, so far as jobs are concerned, to the firm's survival and continued growth. However, the firm can only survive and grow if it is competitive; and increasingly, competitiveness is based on the quality of products. Employees must be aware of this.

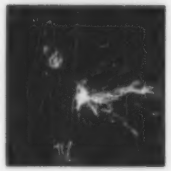
Social needs, such as the need to work as a team, can be satisfied by programs such as "quality circle" programs, which encourage employees to meet and work as a group to identify and solve quality-related problems.

To satisfy employees' needs for *recognition*, the firm can implement concrete programs to recognize work that is well done. For example, some companies offer bonuses or trophies in recognition of the efforts of persons or groups who obtain the best results in terms of quality.

Finally, to give employees an opportunity to satisfy their need for *tangible results*, programs such as those based on "suggestions," "quality circles" or "zero defects" give individuals and groups and opportunity to contribute to quality improvement.

It can be seen from this that performing high-quality work can help satisfy all the workers' needs. It is management's job to make them aware of that.

■ HOW SHOULD THE QUALITY FUNCTION BE ORGANIZED?



The quality function in business firms has evolved over the years: the central inspection department became a *"Quality Control"* department, then a *"Quality Assurance"* department.

A firm's quality department may have:

- *either a **decision-making** role, having responsibility for all controls and the authority to halt production if quality is not achieved or forbid shipment of a lot whose quality is judged to be inadequate;*
- *or an **advisory** role, pointing out any divergence in regard to quality to the operating department responsible, such as the production department, which then must make a decision and, of course, answer for it to management.*

In the past; the department responsible for product inspection was always separate from the production department. The current trend in many firms is to give the production department control over its activities and to concentrate quality assurance and promotion functions within one central department.

The quality department, in firms which have adopted self-checking, coordinates the preparation of policies and objectives concerning quality and, using audits and analyses, assesses the effectiveness of the quality system. It may also do follow-up and check that procedures are being adhered to and that products conform to specifications. In a small firm, these responsibilities may be assigned to a person who is also responsible for other duties.

A manufacturer of electrical equipment reduced the number of inspectors in his operation from 22 to 5 by assigning responsibility for control to the operators. Both productivity and quality improved significantly. Several inspectors now have a production support role and others have been assigned a supervisory role for the quality system.

There is no single ideal structure for the quality function. It depends on the size of the firm and the nature of its operations. However, certain rules are recommended:

- A specific person is given clear responsibility and sufficient authority to coordinate quality measures within the firm. This person is either a member of, or has direct links to, senior management. In larger firm, this person is responsible for the quality department;
- Each person knows his direct responsibilities with respect to quality and has the authority to perform them. Job descriptions are set out and interfaces between various departments are determined by consensus.

It is to the firm's advantage to document its quality system. For example, a manual, procedures, instructions and plans should all be available for consultation. However, it cannot be too strongly emphasized that red tape is to be avoided.

Among other advantages, this documentation helps to:

- *make the relevant policies and guidelines known to everyone in the firm;*
- *enable effective consultation with personnel;*
- *keep customers informed;*
- *ensure that quality measures are internally consistent and maintain continuity over time;*
- *provide an objective basis for checking the system's effectiveness;*
- *preserve the firm's know-how.*

HOW CAN DESIGN INFLUENCE QUALITY?

Design errors are responsible for almost half the defects detected in a firm's products. The consequences of these defects can often be very serious, yet their causes can usually be eliminated at the design stage, and at very little cost.

Design is based on the definition of needs but, just as in production, other factors such as standards, technical specifications and procedures also play a role. Such documents should be available to designers, kept up to date, stored and indexed so that they can be easily used.

What documents are produced at the design stage?

They include everything needed for purchases, production, etc. This means lists of materials, specifications, plans, instructions, etc.

How can these documents be used effectively?

By making sure they are:

- *clear (avoid ambiguities and contradictions),*
- *accurate (aim for objectivity, therefore quantify and eliminate qualifications and approximations),*
- *complete (cover all significant points)*

Generally, it is a good idea to make use of recognized standards in establishing specifications for materials and work methods. Others which may be referred to are the firm's in-house standards or those stipulated by the customer.

Always make sure that drawings, scales and manufacturing instructions are compatible with the plans and inspection and testing instructions.

Designers are often tempted, to be on the safe side, to specify excessively close tolerances. As a result, production costs may rise unduly and the production department may find it extremely difficult to meet these tolerances. Here, it seems essential that the production and design departments communicate with each other.

A similar dialogue must exist between Design and the firm's other departments. For example, Purchasing can advise designers on available materials and components, while Customer Relations can advise them of weaknesses in existing products. Avoid "ivory tower" design work.

Just as it is in production, an approach combining prevention and checks is useful in the design stage. Once the design is complete, changes should only be made in an orderly and systematic manner, making sure that everyone concerned is advised.

HOW DOES PURCHASING AFFECT QUALITY?

Many industrial concerns allocate more than 50% of their sales revenue to purchases of goods and services. To save money, and this is particularly the case in small and medium-sized businesses, purchases are often made from the least-cost supplier, without paying sufficient attention to quality. Yet, the quality of raw materials, parts and components directly affects the final quality of the firm's products, and consequently its performance.

The quality of purchases depends on three main factors:

- *the **description** of the products to be purchased: it must be clear, precise and complete; it should be drawn up using plans, drawings, blueprints, specifications, standards or codes.*
- *the **choice of supplier**: apart from price, other considerations must be taken into account, such as the supplier's expertise, production capacity, technical, human and financial resources, quality program and past performance.*
- the ***conformance of the items received** to the specifications indicated in the purchase order.*

Before placing an order, a firm should satisfy itself that the supplier can deliver the product and its quality should be checked. If that has not been done, and the order is not for products that have previously been bought from the same supplier, the first lots received should be inspected. If the results are satisfactory, this inspection can be replaced by periodic checks, which require far less resources.

In certain sectors, such as automobiles, aviation and electricity, it is current practice for a buyer to examine the documents which describe the quality program of each of his suppliers and to check, at the factory, how it is being observed and how effective it is. In these industries, a subcontractor may be required to perform this type of preventive evaluation of his suppliers.

Often, the purchaser and the supplier only communicate on an as-required basis. Many problems could be prevented by more frequent contact and more sustained communication. Other departments besides Purchasing also have a role to play in purchasing. The firm's quality program should entail making use of their skills and experience to improve the quality of purchases.

HOW CAN YOU CONTROL THE QUALITY OF YOUR PRODUCTS?

If you want to know whether a job is satisfactory, you can perform an inspection.

The purpose of an inspection is to determine the deviation from an objective that has been set beforehand and the actual result of a given activity.

Ideally, this objective is a quantitative specification: 5 cm, 350 g, etc. Sometimes, however, there is no choice but to compare a product with a photograph or a sample. A complete specification sets out not only the required dimension, but also the acceptable tolerance: 5 cm ± 0.1 cm, 350 g ± 10 g.

Before proceeding with an inspection, it is advisable to set out who is inspecting what, where, when, how and how much.

With answers to these questions, a quality control system can be implemented.

What is inspected?

An inspection can be performed on a characteristic of a product (length, weight, surface finish, etc.), the accuracy of a calculation or the information contained in a purchase order. The parameters of a process which can affect the quality of a product can also be inspected.

Who inspects?

Within the firm, the person performing a given task can carry out his own inspection if given the authority and the means needed to do so. This practice should be adopted wherever possible, since it is frequently the most economical, effective and motivating for the personnel involved.

A co-worker may also perform the inspection, if a more objective assessment of the work is desired. This is a current practice with designers. An operator may also inspect the work of another operator on the same production line.

The inspection may also be performed by an inspector whenever special skills and techniques are needed (X-ray, ultrasound, magnetic-particle inspection, etc.) or when an independent quality confirmation is desired.

In addition, a customer may inspect his suppliers' products or, as is becoming increasingly common, be content with checking the inspecions the suppliers have performed, thus saving time and money. The customer may also check the effectiveness of his suppliers' quality programs.

Where, when and how should inspection be performed?

Inspections can be performed at any stage (see Figure 5). Prior to production, an inspection can be performed to determine whether customers' needs have been correctly identified and whether the plans, specifications and purchase orders are clear and complete.

The receiving department checks whether shipments of raw materials received conform to the specifications indicated on the purchase order. The product can be checked at various stages throughout the manufacturing process. The quality of the finished product can be controlled, by inspection or test, to determine whether it conforms to the required specifications and whether it satisfies the needs for which it was designed. Inspections can also be performed to determine whether products are correctly identified and whether their packaging is suitable and in good condition. Further inspections may be carried out when products are installed.

Inspections may be performed periodically at regular intervals, or from time to time, on an as-required basis. They can be performed more or less frequently depending on whether results appear satisfactory or not. There are specific rules on this subject, so that it is possible to optimize the resources allocated to quality control.

There are various types of inspection: visual inspection, dimensional inspection, chemical testing, destructive or non-destructive testing, etc.

Regardless of the inspection method selected, it is a good idea to rely on existing standards, to train personnel and to determine precise criteria for acceptance of raw materials and finished products.

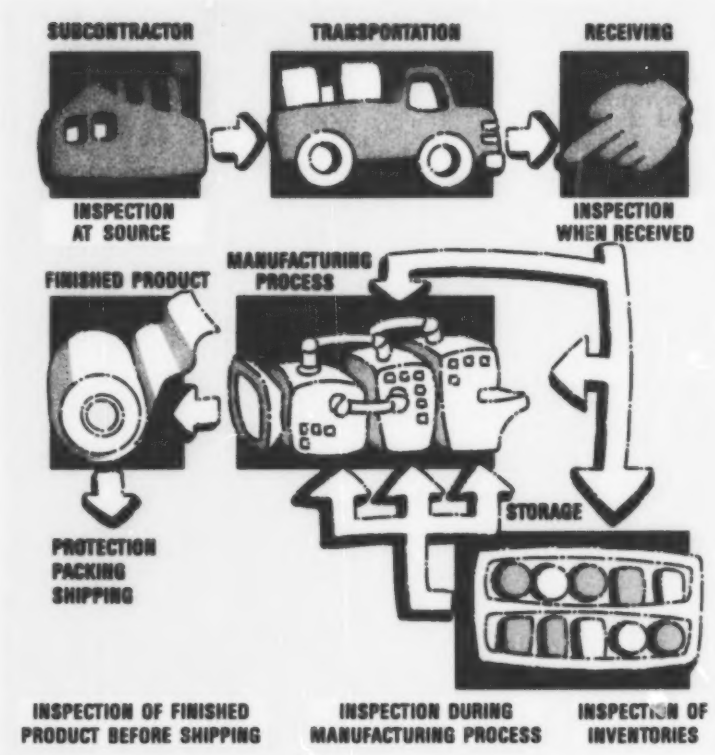


Figure 5. Inspection at various stages.

How much should be inspected?

In certain cases, every item in a lot is inspected (100 % inspection). In other cases, it may be more cost-effective to completely forego inspection, or to inspect only a sample selected at random. The required sampling plan can be easily determined by calculation or by using existing tables prepared for this purpose.

Statistical Process Control

Statistical Process Control (SPC) is based on the fact that any process, regardless of its precision, is subject to variations that are due to a host of unidentifiable causes. The technique consists in taking samples at regular intervals, measuring the characteristic to be examined, such as the weight of a bag of cement, and averaging the measurements obtained.

With a few simple calculations, it is possible to establish limits within which fluctuations of this average compared to the average for the process can be considered acceptable and do not necessitate an adjustment to the process. However, if the average lies outside the limits, the variation is due to an *identifiable* cause, usually a maladjustment in the process. This is a signal indicating, often even before defective units are produced, that corrective measures are needed.

Figure 6 shows a simplified control card which records the results of periodic process controls.

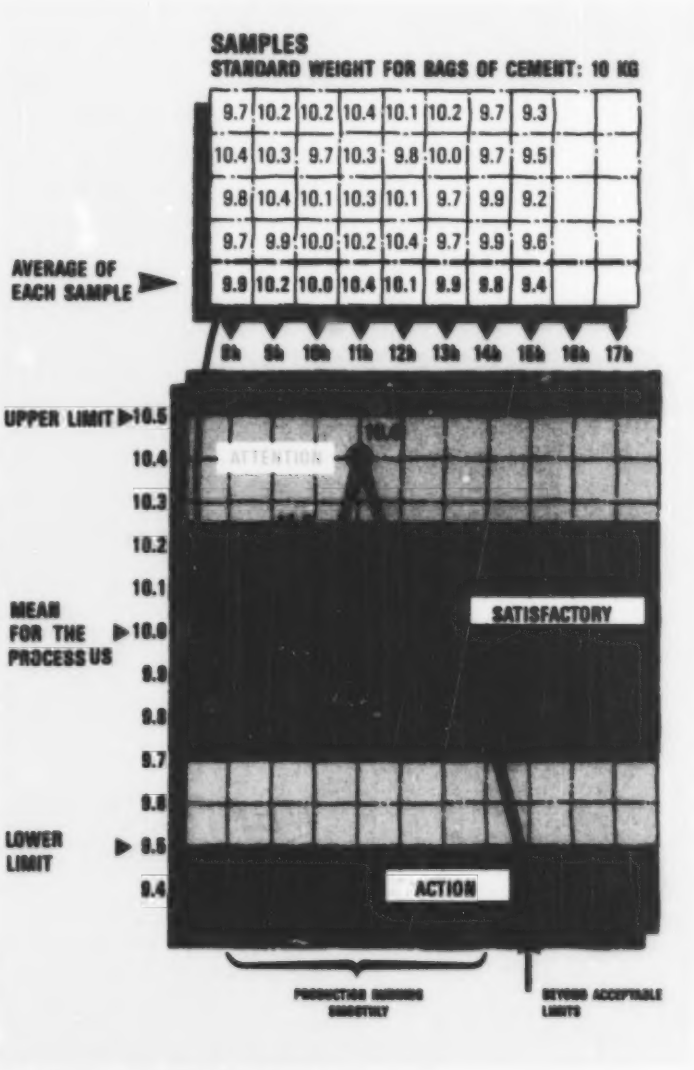


Figure 6. Simplified control card.
A control card: the process can be monitored using averages from samples taken at regular intervals.

HOW CAN YOU ENSURE THE QUALITY OF YOUR PRODUCTS?

Over the years, products have become increasingly complex, and the consequences of their failures more and more serious, in both economic and safety terms. In the 1960s, businesses and their customers felt a need to be assured of the quality of products and services.

A number of manufacturing practices proven in the most advanced firms were standardized and their use became widespread. The purpose of these standards was not only to encourage businesses to turn out quality products, but also to enable them to demonstrate that to their customers.

Today, quality assurance is becoming a prerequisite in an ever-increasing number of fields, and most industrialized countries have adopted national standards.

International standards are currently being developed in this field. Increasingly, firms which export their products can expect to have to measure up to such standards. A firm can get a head start and prepare for the future by implementing its own quality system.

***Quality assurance** can be defined as "the whole range of measures taken to be reasonably confident that the firm's products will satisfy quality requirements." Quality assurance is a type of prevention. Even before a job is begun, all necessary precautions must have been taken to avoid errors or, if, in spite of everything, errors are made, to detect them quickly, correct them and eliminate the causes.*

Quality assurance is now recognized as being an essential part of a firm's quality management system.

WHAT ARE THE COMPONENTS OF A QUALITY ASSURANCE SYSTEM?

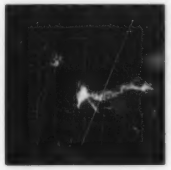
The best way to be confident of the quality of the finished product is to ensure that this quality is built in at every stage (design, purchasing, manufacture, etc.).

At each stage of the process, quality management must be present (planning, organizing, directing and control).

In addition, the means required to build in quality, such as the "seven Ms," must be thoroughly mastered.

The firm's quality manual should include clauses dealing with each of the above items.

HOW CAN YOU DIAGNOSE YOUR SITUATION AND IMPLEMENT A QUALITY SYSTEM?



A quality system can be implemented or improved as follows:

1. ***The starting point is the diagnosis.***

   This involves determining the present level of quality, expressed in rates of defective products, returns, in numbers of complaints or lawsuits, in rates of rejection or rework. The costs of un-quality can also be assessed, as can, using ***"value analysis,"*** *the cost of excess quality.*

   The diagnosis also includes an analysis of the probable causes of un-quality or excess quality and of the consequences for design and production costs, sales and the firm's corporate image.

2. ***The anticipated situation is then evaluated.***

   This evaluation consists in estimating the anticipated internal and external changes in the short and medium terms to change product quality.

3. ***Objectives are set based on the results of the first two stages.***

   These objectives may consist in reducing the percentage of defective products, for example, or the cost of un-quality or of excess quality.

4. ***A plan of action is prepared.***

   The methods to be employed to achieve the objectives are selected. For instance, the firm could decide to emphasize employee training or motivation, or to set up a quality assurance system, or to implement statistical process control or to introduce quality circles. The next step is to draw up an action plan including a detailed program, timetable and budget.

   Various techniques are available for performing the diagnosis, detecting problems and developing possible solutions. These techniques include brainstorming, the cause and effect diagram and Pareto analysis. Courses and seminars on quality management generally deal with these techniques, and make use of practical examples.

To conclude, keep in mind that quality costs nothing. It is unquality and excess quality that generate costs for the firm; eliminating them is therefore an excellent way to significantly improve profitability.

It is essential to always satisfy customers by providing them with quality products while also meeting their requirements relating to quantities, delivery times and costs. For a business, it is the key to excellence.

Implementing a quality system is an investment that can only be profitable.

With this system, a level of quality is attained that will satisfy the customer and increase the firm's profits. It will also improve the job security and well-being of the employee, without whose participation any quality initiative has little chance of succeeding. As this process becomes more widespread, the country becomes more prosperous and its people enjoy a higher standard of living and a better quality of life.

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